UNIVERSITI TEKNOLOGI MARA

PREPARATION AND CHARACTERIZATION OF POLY(L-LEUCINE)-1,3-DIAMINO PROPANE (PLL)-LITHIUM IODIDE (LiI) AS SOLID POLYMER ELECTROLYTE

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DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the result of my own work, unless otherwise indicated or acknowledge as referenced work. This topic has not been submitted to any other academic institution or non-academic institution for any other degree or qualification.

In the event that my thesis be found to violate the conditions mentioned above, I volunrarity waive the right of conferment of my degree and agree be subjected to the disciplinary rules and regulations of Universiti Teknologi MARA.

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ABSTRACT

The quest of new materials for solid electrolyte is unlimited. In this work, poly amino acid that is poly(L-Leucine)1,3-diamino propane (PLL) has been chosen as the host for solid polymer electrolyte. Solid polymer electrolyte containing PLL was prepared via low temperature sintering method. The PLL was mixed with lithium iodide (LiI) at various wt %, ground, pelletized and then sintered at 90^{o}C in a vacuum oven to initiate the reaction and maintained at that temperature for 3 days (72 hours). The electrical conductivity of the samples was measured using impedance spectroscopy technique. The maximum conductivity of 1.7×10^{-4} S/cm at room temperature was obtained for the sample containing 50 wt % of LiI. The conductivity was contributed by lithium ions since the ion transfer move with high mobility in the system. The ionic transference number of the lithium ions for the sample with the highest electrical conductivity is 0.88. The ionic conductivity was related to the structure of the material and was investigated using infrared technique (FTIR). FTIR was employed to verify the chelation of cation at C=O of PLL at wavenumber of 1642 cm^{-1}. The band at 1642 cm^{-1} have shifted to lower wavenumber and this confirms that complexation has occurred in the sample. The X-ray diffraction result revealed that the poly(L-Leucine)1,3-diamino propane (PLL) is semi-crystalline and LiI is crystalline in nature. The XRD diffractogram of various PLL-LiI samples showed that some of the peaks have disappeared and the peak at $2\theta = 10 - 18^{o}$ has broadened in PLL-LiI samples. The sample has become more amorphous with LiI added. The temperature dependence conductivity was done from 30^{o}C to 90^{o}C to determine the conduction mechanism. It was found that the conduction mechanism follows the Vogel-Tamman-Fulcher (VTF) characteristics.

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CHAPTER 1

INTRODUCTION

1.1 Background

The development of electrolyte in electrochemical devices has accelerated due to ever increasing demand and current market trend in electronic devices such as hand phone, laptop and other gadgets. Day to day, electronic devices have become diversified with the power consumption rate and weight factors need to be considered. When dealing with weight, solid electrolyte is the lightest compared to liquid and gel electrolyte [1].

Solid electrolytes are electronic insulators and usually used as energy storage. The crystal bonding in solid electrolyte is ionic in nature with electrical conductivity about 10^{-1} to 10^{-4} S/cm and electronic conductivity must be small [2]. According to Mcgeehin and Hooper [3], general features of solid electrolyte that can be considered as ionic conductors are those containing large number of mobile ion (10^{-22} cm^{-3} in most cases) and large number of available sites for the mobile ion to jump. Each of these mobile ions have similar amount of energy and approximately having the same co-ordination. Ionic conductor usually has low potential barrier to the motion of the ions and structures with continuous chain of face-sharing octahedral and tetrahedral through which the ions can diffuse, mostly in three dimensions. All these features will contribute to high electrical conductivity of a solid electrolyte.

The following are the fundamental principles governing the commercial application of solid electrolytes. The material provides an impervious barrier to gases and liquids but allow one or more kinds of ions to migrate through its lattice when there is a tendency for such migration to exist. This tendency is induced by a potential gradient generated either through an applied voltage or through a chemical potential gradient